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**The Effects of Restricting or
Banning Atrazine Use to Reduce
Surface Water Contamination in
the Upper Mississippi River Basin:**

A Summary

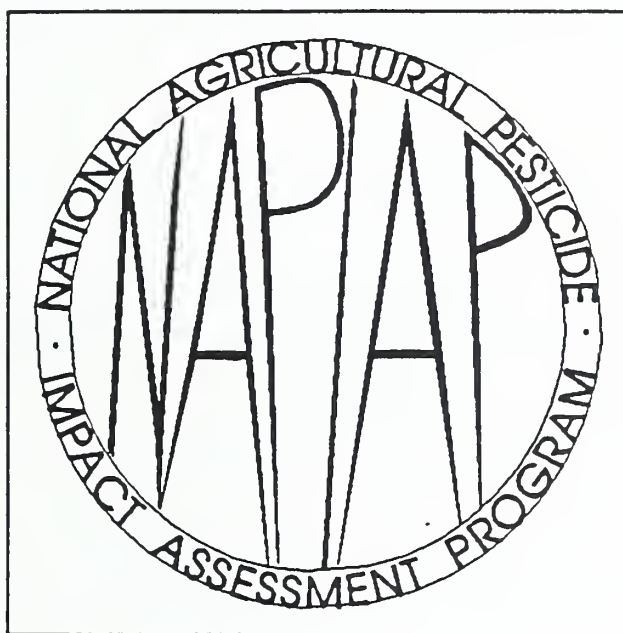
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The Effects of Restricting or Banning Atrazine Use to Reduce Surface Water Contamination in the Upper Mississippi River Basin:

A Summary



**Coordinated and Prepared by
The National Agricultural Pesticide Impact Assessment Program**

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U.S. DEPARTMENT OF AGRICULTURE
NATIONAL AGRICULTURAL PESTICIDE IMPACT ASSESSMENT PROGRAM

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Atrazine has been identified as a potential pollutant of surface water in the midwestern U.S. A U.S. Geological Survey (USGS) study of 122 river basins in 12 midwestern States found that transient atrazine concentrations exceeded the U.S. Environmental Protection Agency's maximum contaminant level (MCL) for drinking water, which is 3 parts per billion, in 27 percent of raw water samples. As a result, the U.S. Environmental Protection Agency might restrict or ban the use of atrazine in the affected areas.

Atrazine is a triazine herbicide used to control broadleaf and grassy weeds and was first marketed to U.S. farmers in 1959. It is the most widely-used herbicide in U.S. corn and sorghum production. Corn accounts for 80 percent and sorghum 10 percent of atrazine use. Conservation tillage programs for corn and sorghum production rely heavily on atrazine for weed control. Sugarcane accounts for 3 percent of total use, and the remainder is applied to a variety of sites including conifers, guava, macadamias, proso millet, pineapples, rangeland, turf grasses, and noncropland uses. Although there are a number of registered herbicides for use on these commodities, they do not control the same spectrum of weeds and are not as cost-effective as atrazine.

The NAPIAP Assessment of Atrazine Benefits

In response to concerns about atrazine, the U.S. Department of Agriculture and State Universities, in a cooperative effort under the National Agricultural Pesticide Impact Assessment Program (NAPIAP), assessed the impacts of potential restrictions on atrazine and other triazine use in the midwestern States included in the USGS survey. The assessment focused on corn and sorghum, because they are the major use sites for atrazine in these States. For corn, the study region included the Corn Belt (Illinois, Indiana, Iowa, Missouri, Ohio), the Lake States (Michigan, Minnesota, Wisconsin), the Northern Plains (Kansas, Nebraska, South Dakota), and Kentucky. For sorghum, the study region included the Northern Plains (Kansas and Nebraska). Based on their knowledge of field production data, weed scientists in these States estimated changes in crop management practices and yield that would result from four potential use restrictions:

- Limit 1) Restrict atrazine application rates to 1.5 pounds active ingredient (a.i.) per acre on preemergence applications and to 1 pound per acre on postemergence applications,
- Limit 2) Restrict atrazine application rates to 1 pound a.i. per acre on postemergence applications and ban all other atrazine applications,
- Limit 3) Ban the use of atrazine, and
- Limit 4) Ban the use of atrazine and all other triazines (including ametryn, cyanazine, metribuzin, and simazine).

The last restriction was included because other triazines could create drinking water problems similar to those caused by atrazine if their use increased to replace atrazine.

Only currently available herbicides and weed control practices were considered as alternatives to atrazine or triazines. Current research in developing herbicide-resistant corn

could significantly impact weed management strategies by promoting the use of postemergence herbicides. The practice would reduce surface water run-off and lower the potential for water contamination. However, since this practice is not currently available to farmers and there are no data available on the ramifications of its use, this strategy was not considered as an option in the assessment.

Current Use of Atrazine and Other Triazines

About 51 million pounds active ingredient (a.i.) of atrazine are applied to 40 million corn acres, approximately 62 percent of the corn acreage in the study region (table 1). The average application rate is about 1.3 pounds a.i. per acre. Other widely-used triazines are cyanazine and simazine. Approximately 51 million corn acres, 80 percent of the corn acreage in the study region, are treated with one or more triazine herbicides.

While the number of corn acres treated with atrazine has remained stable since 1982, the actual amount applied has been reduced by approximately 20 percent. Lower application rates, use of other herbicides alone or in combination with atrazine, development of atrazine-resistant weeds, scouting programs, and increased grower awareness of the potential for surface and groundwater contamination have led to this reduction.

Approximately 4.1 million pounds a.i. of atrazine are applied to 3.8 million sorghum acres in the Northern Plains, or 67 percent of the sorghum acreage in the study region (table 1). The average application rate is about 1.1 pounds a.i. per acre. Other triazines are much less widely used on sorghum; cyanazine is only used on about 2 percent of the acreage in the Northern Plains.

Economic Losses

As the potential actions become more restrictive, they would cause greater economic losses (table 2). The annual economic losses, measured by the sum of producer plus consumer losses, would be \$80 million, \$320 million, \$810 million, and \$1.2 billion for limits 1 through 4, respectively. Limit 1 would reduce atrazine use, as measured by pounds a.i., in the study region by 17 percent, limit 2 by 68 percent, and limits 3 and 4 by 100 percent (table 1 and figure 1).

The potential actions would become less cost-effective in reducing atrazine use as they become more restrictive. The average economic loss per pound a.i. of atrazine reduced would increase from \$8 per pound for limit 1, to \$9 for limit 2, to \$15 for limit 3. The average economic loss of eliminating all triazines would be about \$16 per pound a.i. of triazines (limit 4).

Restrictions on atrazine or triazines would decrease yield and/or increase cost on treated acreage (table 2). Average corn yield losses on treated acreage would range from less than 0.1 percent for limit 1 to almost 7 percent for limit 4. Average sorghum yield losses would

range from 0 percent for limit 1 to 18 percent for limits 3 and 4. The application rate restrictions (limits 1 and 2) would have smaller yield losses, in part, because not all atrazine acreage would be affected. Approximately, 11 percent of corn acreage and 10 percent of sorghum acreage treated with atrazine in the study region would be affected by limit 1; about 55 percent of corn and 38 percent of sorghum acreage treated with atrazine would be affected by limit 2.

The yield losses and cost changes of banning atrazine or all triazines would be large enough to increase crop prices. The price and welfare implications were evaluated with the AGSIM Model developed by C.R. Taylor of Auburn University. Banning atrazine (limit 3) in the study region would increase corn price by 1 percent and sorghum price by 3 percent (table 2). Banning all triazines (limit 4) in the study region would increase corn price by 4 percent and sorghum price by 3 percent.

The price increases in limits 3 and 4 would partially offset producer income losses caused by lower yields and higher production costs, but would also cause consumer losses. Producer income would decrease \$342 million under an atrazine ban (limit 3) and \$52 million under a triazine ban (limit 4)(table 2). Consumer losses, domestic and foreign, would be \$470 million for banning atrazine and \$1.19 billion for banning triazines. The price changes would also influence planting decisions for corn, sorghum, as well as the production and prices of other crops. Corn and sorghum production would be likely to increase in areas not affected by the bans.

Effect on Alternative Practices

The restrictions on atrazine or triazines would increase the use of other herbicides and cultivation (table 1). Weed control treatments (the sum of acres treated with each herbicide alternative and acres receiving additional cultivation) would increase by 13 percent of triazine acres under limit 1, 23 percent under limit 2, 24 percent under limit 3, and 34 percent under limit 4 (figure 2). Overall, the total treatments of herbicides would not decrease under any of the restrictions. The quantity of herbicides, as measured by pounds a.i., would only decrease if all triazines were banned (figure 1).

Many corn producers would use other triazine herbicides, primarily cyanazine or simazine, in response to restrictions or bans on atrazine (table 1, figures 1 and 2). The triazine alternatives would often need to be applied at rates higher than currently used. As a result, the atrazine restrictions (limits 1, 2, and 3) would decrease the acres treated with triazines, but triazine quantity, as measured by pounds a.i., would decrease proportionally less than acreage treated. Sorghum producers would rely much less on triazine alternatives than corn producers would, because of the higher cost and potential crop injury of the triazine alternatives. If triazines were banned, farmers would rely more heavily on postemergence herbicides with lower application rates. Although total treatments with herbicides would not decrease, chemical use on triazine acres, as measured by pounds a.i., would decrease 36 percent of triazine weight.

Cultivation would increase as the potential actions become more restrictive, potentially increasing soil erosion and sedimentation problems (figure 2). Farmers would add one or more cultivations on 5 percent of atrazine acres (4 percent of triazine acres) under limit 1, on 16 percent of atrazine acres (12 percent of triazine acres) under limit 2, and on 25 percent of atrazine acres (19 percent of triazine acres) under limit 3. If triazines were banned, 33 percent of triazine acres would receive at least one additional cultivation.

This study did not estimate the effect that the restrictions would have on the contamination of surface water with atrazine, other triazines, other pesticides, or sediment. However, the increased use of alternative chemicals and cultivation potentially creates other health or environmental problems, including water quality problems, that should be evaluated before banning or restricting atrazine or triazine use.

Table 1. Effects of Restrictions on Use of Atrazine, Triazines, and Alternatives in Corn and Sorghum Production in 12 Midwestern States.¹

Item	Current Use	Percent Change in Use Caused by:			
		Limit 1	Limit 2	Limit 3	Limit 4
Herbicide Quantity					
	Million Pounds a.i.	Percent of Atrazine Quantity			
Atrazine:					
Corn	50.6	-18	-69	-100	-100
Sorghum	4.1	-7	-55	-100	-100
Total	54.7	-17	-68	-100	-100
All Triazines:		Percent of Triazine Quantity			
Corn	72.3	3	-8	-1	-100
Sorghum	4.1	-7	-53	-97	-100
Total	76.4	2	-11	-6	-100
All Chemical Alternatives					
Corn	NA ²	5	1	16	-38
Sorghum	NA	3	-24	9	7
Total	NA	5	0	16	-36
Acreage of Practices					
	Million Acres	Percent of Atrazine Acres			
Atrazine:					
Corn	39.5	-9	-54	-100	-100
Sorghum	3.8	0	-38	-100	-100
Total	43.3	8	-53	-100	-100

Table 1. Effects of Restrictions on Use of Atrazine, Triazines, and Alternatives in Corn and Sorghum Production in 12 Midwestern States.¹

Item	Current Use	Percent Change in Use Caused by:			
		Limit 1	Limit 2	Limit 3	Limit 4
All Triazines:		Percent of Triazine Acres			
Corn	50.8	2	-17	-37	-100
Sorghum	3.9	0	-37	-97	-100
Total	54.7	2	-19	-41	-100
All Chemical Alternatives					
Corn	NA	8	11	6	1
Sorghum	NA	24	11	0	-1
Total	NA	9	11	5	1
Additional Cultivation					
Corn	NA	4	12	20	34
Sorghum	NA	4	9	16	20
Total	NA	4	12	19	33

1. Limit 1 = 1.5 lb. a.i. per acre restriction on preemergence atrazine applications, 1 lb. per acre restriction on postemergence applications. Limit 2 = 1 lb. a.i. per acre restriction on post-emergence atrazine applications, ban all other atrazine applications. Limit 3 = ban atrazine use. Limit 4 = ban all triazine use.

2. Not Available

Table 2. Economic Effects of Atrazine and Triazine Restrictions¹

Item	Limit 1	Limit 2	Limit 3	Limit 4
Million Dollars				
Producer Income				
Corn	-72	-304	-320	-32
Sorghum	-6	-18	-18	-8
Other			-4	-12
Total	-72	-321	-342	-52
Consumer Effect				
Domestic	* ²	*	-370	-936
Foreign	*	*	-171	-258
Total	*	*	-471	-1,194
Total Economic Effect	-78	-321	-813	-1,246
Percent				
Price Changes				
Corn	*	*	*	4
Sorghum	*	*	-4	3
Change in US Production				
Corn	** ³	-0.8	-1.2	-3.0
Sorghum	0.0	-0.7	-1.6	-1.0

Table 2. Economic Effects of Atrazine and Triazine Restrictions ¹				
Change in US Acreage	Percent			
Corn	*	*	0.1	0.7
Sorghum	*	*	3.0	3.4
Yield Change per Treated Acre				
Corn	**	-1.3	-3.2	-6.6
Sorghum	0.0	-1.9	-18.1	-18.2
	Dollars			
Cost Change per Treated Acre				
Corn	1.0	4.5	9.2	3.8
Sorghum	1.7	2.4	6.5	6.5

1. Limit 1 = 1.5 lb. a.i. per acre restriction on preemergence atrazine applications, 1 lb. per acre restriction on postemergence applications. Limit 2 = 1 lb. a.i. per acre restriction on postemergence atrazine applications, ban all other atrazine applications. Limit 3 = ban atrazine use. Limit 4 = ban all triazine use.

2. * = Insignificant

3. ** = Corn production would decrease by 0.03 percent, while average corn yield per treated acre would decrease by 0.05 percent.

NAPIAP Atrazine Assessment Team

Team Chairman:

David Pike
Dept. of Agronomy
University of Illinois
Urbana, IL

Alex R. Martin
Agronomy Dept.
University of Nebraska
Lincoln, NE

State Respondents:

Thomas T. Bauman
Botany and Plant Pathology Dept.
Purdue University
West Lafayette, IN

Michael D. K. Owen
Agronomy Dept.
Iowa State University
Ames, IA

Orvin C. Burnside
Agronomy and Plant Genetics
University of Minnesota
St. Paul, MN

David A. Regehr
Agronomy Dept.
Kansas State University
Manhattan, KS

Sharon Clay
Plant Science Dept.
South Dakota State University
Brookings, SD

Loyd M. Wax
Crop Protection Research
Agricultural Research Service, USDA
Urbana, IL

Jeffry Gunsolus
Agronomy and Plant Genetics
University of Minnesota
St. Paul, MN

William W. Witt
Agronomy Dept.
University of Kentucky
Lexington, KY

Robert Hartzler
Agronomy Dept.
Iowa State U.
Ames, IA

USDA Participants:

Ron Davis
Pesticide Research Staff
Agricultural Research Service
Beltsville, MD

Craig Osteen
Agricultural Inputs and Production
Systems Branch
Economic Research Service
Washington, DC

James J. Kells
Crop and Soil Sciences
Michigan State University
East Lansing, MI

Kent Smith
Pesticide Research Staff
Agricultural Research Service
Beltsville, MD

Mark Loux
Agronomy Dept.
The Ohio State University
Columbus, OH

Figure 1 – Use of Herbicides on Triazine Acres

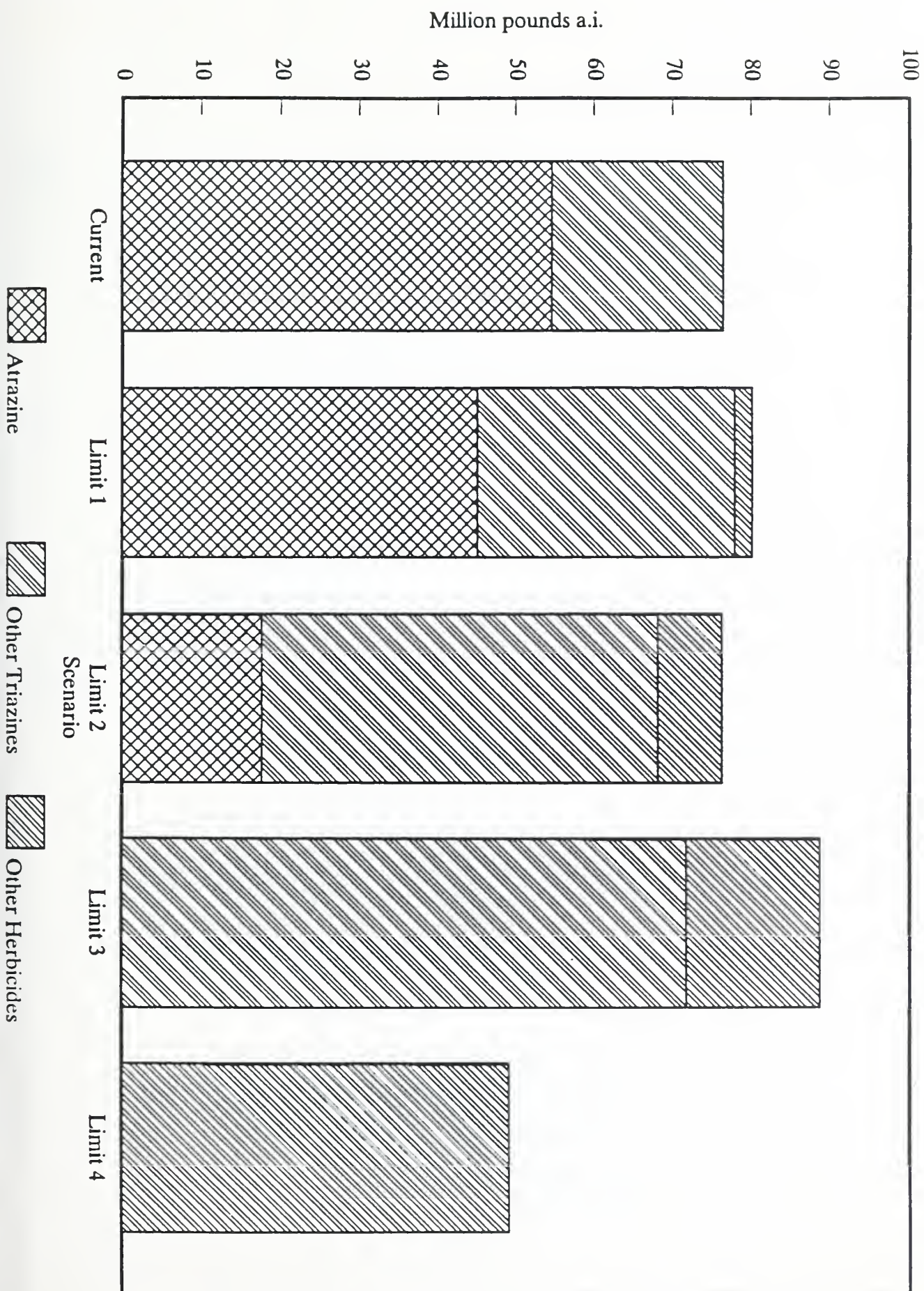
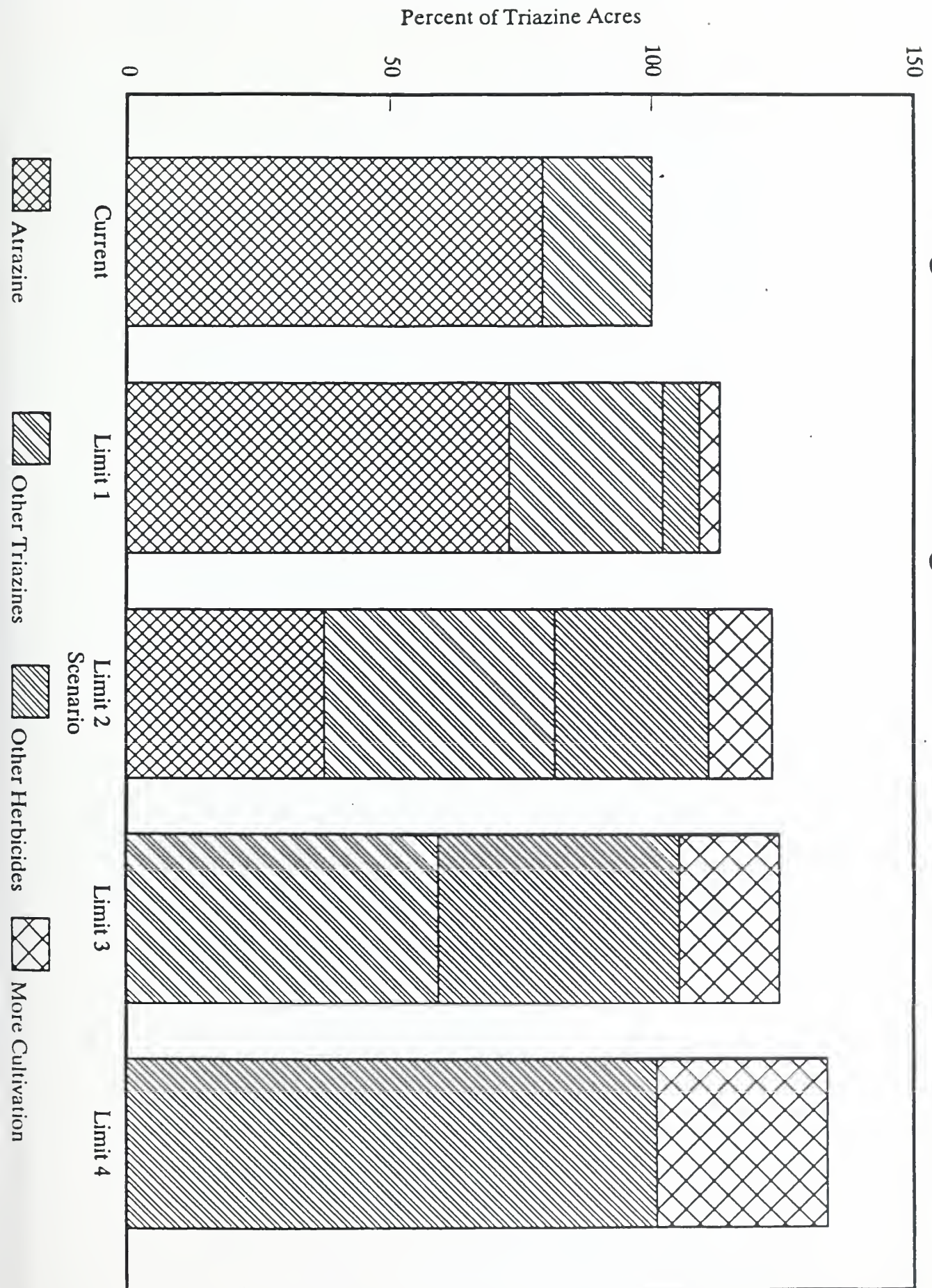


Figure 2 – Change in Weed Control Treatments





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